ASTEROIDEA

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h collection of Asteroidea made at great ep s in the Mid-Atlantic by the Swedish ee -sea Expedition in 1948 only comprises 9 le fiable species, of which none are new to cie e, besides an unidentifiable Pterasterid. ev theless the collection must be considered er important since it strongly stresses the u sition that the real deep-sea fauna is sse ially cosmopolitan. Three of the 9 species re ew to the Atlantic, viz. *Eremicaster ac cus*, hitherto only known from the eastern ac c, *Chunaster scapanephorus*, hitherto only no n from the East Indies, and *Freyella en phila*, hitherto known from the Mid- ac c and the Bay of Bengal. One species, *re lla tuberculata*, was recorded from the id Pacific as well as from the Atlantic, and no er species, *Thoracaster cylindratus*, is also ist buted besides in the Atlantic in the eastern ac c, but was here recorded under the name *T magnus*. Three of the remaining species, *Por llanaster cæruleus*, *Styracaster horridus*, nd *Hyphalaster parfaiti*, are represented in he ndopacific by species which are very ea y related to and may prove identical ri the Atlantic ones, and, in fact, Wood- as N & Alcock, 1891, have recorded spe- im s from the Indian Ocean under the two rst nentioned names, the correctness of the ler fications, however, being doubted by ot LER, 1909.

O y few species of sea-stars have hitherto ee recorded as being cosmopolitan; the xa ination of the present collection, however, di tes that a thorough, critical revision of the deep-sea species described will prove that more of them have actually a worldwide distribution, but hitherto have incorrectly been described as different species in the different oceans. Future collecting in the deep-sea may be expected to add to this number, and is also much called for in order to elucidate the intraspecific variation in the different deep-sea species of which so many are known only in a single or a few specimens. A priori it was to be expected that the species of sea-stars with the widest distribution were to be found among those known from the greatest depths, and this seems also to be confirmed by the present collection.

Three typical deep-sea families of Asteroidea are represented in the collection: the Porcellanasteridae, with 6 species, the Pterasteridae, with 1 species, and the Brisingidae, with 3 species.

The Porcellanasteridae forms an isolated group among the phanerozoniate asteroids, and Fisher, 1911 a p. 22, also proposed that the family might be referred to an order of its own, *Cribellosa*, coordinate with Ludwig's Notomyota, the Paxillosa of Perrier in a restricted sense, and Perrier's Valvata. In the Porcellanasteridae several genera and many species have been described, the number of which, however, has again been reduced somewhat when new collections have made the variations within the single species better known. Our increased knowledge of the family necessitates some small changes in the key

to the genera given by FISHER, 1911 a p. 23, an emendation of SLADEN's key of 1889, and a new emended and simplified key is therefore given below.

Key to the genera of Porcellanasteridae

(The family is characterized by the highly developed cribriform organs).

A. Ambulacral furrows wide and exposed.
  B. Component structure of cribriform organs lamelliform.
    C. 1 cribriform organ: *Porcellanaster*.
    CC. 3 cribriform organs: *Eremicaster*.
  BB. Component structure of cribriform organs papilliform; 1 cribriform organ: *Sidonaster*.

AA. Ambulacral furrows narrow and concealed.
  D. Superomarginal plates with robust spines along the median line of arm.
    E. No ventrolateral plates in arms: *Styracaster*.
    EE. Ventrolateral plates to tip of arms: *Chunaster*.
  DD. No robust spines along median line of arms.
    F. Cribriform organs present only between the marginals of the disk.
      G. A sutural division in the midradial line: *Hyphalaster*.
      GG. An unpaired marginal plate in the midradial line: *Thoracaster*.
    FF. Cribriform organs between all the marginals and on part of dorsal surface of arms: *Benthogenia*.

Porcellanaster cæruleus Wyville Thomson 1877

LIEBERKIND 1935, pp. 5—19, text-figs. 1—5, pls. 2 1—8, 3 12, 5 16—17. (With list of literature).

Material: St. 329 (Haul No. 3), N 0
W 26° 20′ — N 09° 50′ W 26° 30′, Jul
1948; depth 5,610—5,600 m. 5 juv
specimens.

These specimens agree with the descri
which KOEHLER, 1909 b p. 25, gave
specimen from 12° 07′ 30″ N, 33° 32′ 4
6,035 m, which he named *Albatros*
richardi. This specimen had R. 10 mm
mm, 5 superomarginal plates, 2—5 i
marginal plates on either side, and 1
adambulacral plates. The measuremen
the present specimens are as follows:

R.	r.	Number of supero-marginals.	Number of infero-marginals.	Numl ada lac
10.5 mm	5 mm	4	2—5	
10 mm	5 mm	3	2—3	
9 mm	4 mm	4	1	
8 mm	3 mm	4	1	
8 mm	3 mm	4	2—3	

Ventrolateral plates are not found i
of the present specimens. The adambu
plates bear a pair of flattened, blunt
slightly concave spines, which, when
away from the furrow and lying ove
adambulacral plates, strongly recall p
lariae. The superomarginals are unarmed
dorsal side is provided with a skelet
more or less scattered, rather large, roun
perforated plates. In the larger spe
there are, in addition, in the interradia
some very small plates each with a
spinelet. In all the specimens there is
along the interradial line and especially
the madreporite a number of well dev
pedicellariae. An apical peduncle is
pronounced in a few of the specimen
may, apparently, also be absent. There
terminal spines.

The specimens represent a develop
stage nearly corresponding to that
specimen which LIEBERKIND, op. cit.,
in fig. 1, lower row to the left, and in

present specimens, and *Albatrossaster rdi*, are, it is true, about three times as as North-Atlantic specimens at the same opmental stage and larger than the developed specimens from that area; otherwise there are no noticeable differes between them. SLADEN, 1889, also gives arger radius of the type-specimen from astern Atlantic, off New Jersey, as 22 which is about twice the size of the st known North-Atlantic specimens. The ence in size between the North-Atlantic the present specimens at the same demental stage (and age?) no doubt is o the better food supply in the eastern Atlantic. The juvenile specimens collected he »Ingolf» were connected through all itional stages with specimens whose idenwith *P. cæruleus* were beyond doubt, and not hesitate, therefore, to refer the present mens, as also *Albatrossaster richardi*, to *llanaster cæruleus*.

cæruleus, the genotype of *Porcellanaster* he first Porcellanasterid to be described, riginally recorded from off the east coast rth America, and later on a series of new es were described from the Indopacific ll as from the Atlantic. LUDWIG already ted the validity of all these species in and in 1935 LIEBERKIND, in his treatof the Porcellanasterids of the »Ingolf» lition, gave a revision of the Atlantic es of the genus, after having re-examined mber of the types; LIEBERKIND showed most of these were only synonyms of *æruleus*, viz. *P. eremicus* Sladen 1889, *ermis* Perrier 1894, *Caulaster pedunculatus* er 1894, and *C. sladeni* Perrier 1894, and rther showed that the genus *Albatrossia lbatrossaster*) of LUDWIG 1907 was only a ile *Porcellanaster*; but, since he had no occao re-examine any of the specimens referred e genus, he did not give any opinion as to ossible identity of the species of *Albatrossia* any of the other species of *Porcellanaster*.

LIEBERKIND recognizes, besides *P. cæruleus*, two other species of *Porcellanaster* in the Atlantic, viz. *granulosus* Perrier 1894, known in 5 specimens from three localities near the Cape Verdes, 2,320 to 3,200 m, and *irregularis* described by himself in 1932 on 3 specimens from a single locality off Liberia, 2,492 m. The first of these species seems well distinguished from *cæruleus*, cf. the redescription given by LIEBERKIND, 1935 p. 11. The other species, however, is very insufficiently separated from *cæruleus*, as the character said to distinguish it from this species, the irregular arrangement of the marginal plates, is of doubtful systematic value. The irregularity in the three specimens may be explained as a casual variation in a small population.

From the western Indopacific four species of *Porcellanaster* are recorded, viz. *P. caulifer* Sladen 1883 from four localities in the Arabian Sea, the Bay of Bengal, and the East Indies, 1,460 to 3,010 m, *P. tuberosus* Sladen 1883 from a single locality off Japan, 3,429 m, *P. fragilis* Döderlein 1921 from two localities in the East Indies, 1,158 to 1,914 m, and *Caulaster dubius* Koehler 1909 from a single locality in the Bay of Bengal, 3,200 m. WOOD-MASON & ALCOCK, 1891, recorded, p. 13, from the Arabian Sea, 1,350 m, a *Porcellanaster* »in all important particulars *P. cæruleus*», and, p. 433, from the Bay of Bengal, 1,250 m, *P. cæruleus*. According to KOEHLER 1909 a the first mentioned of these belong to *Sidonaster*, while the last mentioned, though they are Porcellanasters, are too poorly preserved for it to be ascertained whether they are also *P. cæruleus* or not. WOOD-MASON & ALCOCK further mention some juvenile Porcellanasters from two localities in the Bay of Bengal, 3,010 and 3,200 m, which »may perhaps be the young of *P. cæruleus*». One of these specimens is that on which KOEHLER based his *Caulaster dubius*.

P. tuberosus and *fragilis* are apparently very nearly related to *cæruleus* whereas *caulifer*

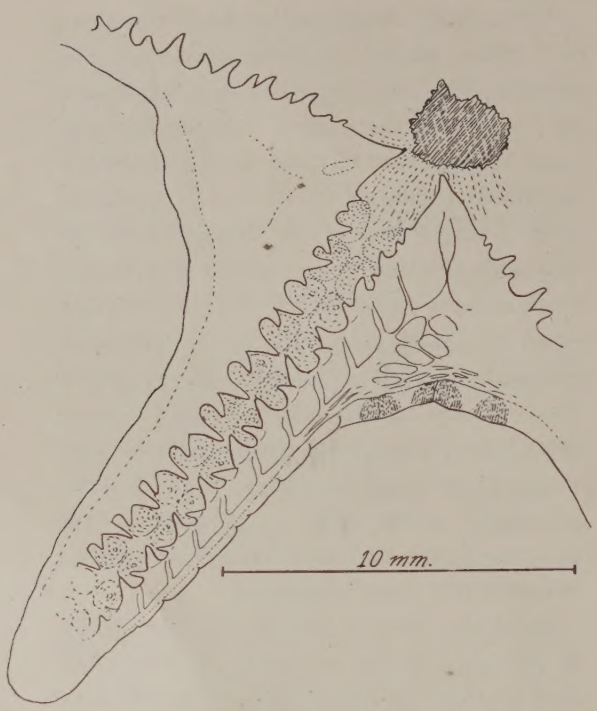

Fig. 1. *Eremicaster pacificus*. Part of ventral side of the larger specimen. The thick skin covering has been partly removed to show the skeleton.

seems well distinguished from it. The affinity of *C. dubius* cannot be ascertained owing to its young age.

Adult Porcellanasters have hitherto not been recorded from the eastern Pacific; but LUDWIG, 1907, described two species from off northern South America, *Albatrossia nudus* and *A. semimarginalis*, which should be regarded as juvenile Porcellanasters, cf. LIEBERKIND 1935 pp. 15—17. The other species from the eastern Pacific which have been referred to *Porcellanaster* belong to the genus *Eremicaster*.

The distribution of *P. cæruleus*, the best known of the genus, comprises the whole Atlantic from just south of the subaquatic ridges connecting Greenland with Iceland and North America southwards to off the Cape. Whether it also occurs in the Indopacific cannot be said with certainty at present, but it seems very likely.

Its bathymetrical range is from 1,4 6,035 m, the latter depth, which refers t specimen described as *Albatrossaster ric* being the greatest depth where a sea-st hitherto been collected.

Eremicaster pacificus (Ludwig 190

Fig. 1.

Porcellanaster pacificus LUDWIG 1905 pp 92, pl. 6 28—29.

Eremicaster p. FISHER 1911 a pp. 29—, 2 1—3. H. L. Clark 1913 p. 187; 1920

Porcellanaster vicinus, + *vicinus* var. *i* LUDWIG 1907 p. 318.

Eremicaster v. H. L. CLARK 1920 pp. 7 pl. 2 7—8.

Material: St. 329 (Haul No. 3), N W 26° 20′—N 9° 50′ W 26° 30′, Jul 1948; depth 5,610—5,600 m. 2 spec

Measurements of the specimens:

R.	r.	Number of superomarginals.	Numb adambul
19—20 mm	8 mm	8—9	13—
18—19 mm	8 mm	6—7	13—

The dorsal side of the disk has a short peduncle and is provided with scattere small calcareous plates each with a spinelet. The superomarginals nos. 4 the larger specimen and nos. 3—5 smaller one each bear a small spine o upper edge. The terminal plates bea spines. In the larger specimen there are interbrachium four cribriform organs of the typical three. The median and cribriform organs consist of up to a dozen rows of flat spinelets. The ventr plates are naked. The adambulacral are provided with two diverging sp larger one at the adoral end and a so smaller one close to it. The jaws, besi single median spine, are provided w

spines aborally on either side. The ventral surface is covered with a fairly skin.

genus *Eremicaster*, originally erected SHER in 1905 as a subgenus of *Porcellan-* was known only from the eastern c until MACAN in 1938 recorded one of ecies from the northwestern Indian Ocean. Swedish Deep-Sea Expedition has now d that the genus is distributed also in the tic.

genus *Eremicaster* sensu FISHER differs *Porcellanaster* in having three cribriform s instead of one only. Generally the er of cribriform organs can not be relied as a distinguishing character since it is t to variation with age as well as to dual variation, as will also appear from bove short description of the present nens. It seems, however, justified to his character in the case of *Eremicaster* s *Porcellanaster;* and *Eremicaster* then rises six species, only three of which, wever, can be considered valid, viz.

crassus (Sladen 1883) from the South c, mid-ocean, 4,270 m, the juvenile form ich is probably *E. gracilis* (Sladen 1883) off Chili, 4,070 m.

tenebrarius (Fisher 1905) [syn. *E. walt-* (Ludwig 1905)] from many localities in astern Pacific, S. Alaska to Peru, and ocality in the northwestern Indian Ocean, to 5,121 m.

pacificus (Ludwig 1905) recorded from localities in the eastern Pacific, Bering o Equador, 1,550 to 4,020 m, and no comprising also *E. vicinus* (Ludwig from off Peru, 5,120 to 5,780 m.

two former species, *crassus* and *tene-s*, are nearly related and characterized aving segmental papillae, whereas such t found in *pacificus*, or *vicinus*. LUDWIG ht the presence or absence of segmental ae a more important character than the er of cribriform organs and therefore retained *pacificus*, and *vicinus*, in the genus *Porcellanaster*. FISHER, 1911 a, however, found the number of segmental papillae to be variable, for which reason he considered the number of cribriform organs the best character for separating *Eremicaster* from *Porcellanaster*, the more so as he found *pacificus* in its general characters much more related to *tenebrarius*, the genotype of *Eremicaster*, than to *cæruleus*, the genotype of *Porcellanaster*.

The present specimens agree with the specimens described by LUDWIG, 1907 p. 318, as *E. vicinus* in having only two small spines on either side of the jaws, in having naked ventrolateral plates, in having only three terminal spines, and in being without spines on the first two or three superomarginals. They further lack spines also on the last two superomarginals and thus form a transitional stage to the few specimens totally lacking superomarginal spines which LUDWIG records as *vicinus* var. *inermis*.

E. pacificus, as described by LUDWIG, 1905, and FISHER, 1911 a, in contrast to *vicinus*, has ventrolateral plates with spinelets, five or seven terminal spines, a spine on each superomarginal plate, and jaws with two to five fairly large spines on either side. If we consider the variation which, according to the careful investigation made by LIEBERKIND, 1935, is found within such other Porcellanasterids as *Porcellanaster cæruleus* and *Hyphalaster parfaiti*, these characters alone, would not, however, be sufficient for keeping *vicinus* as a species distinct from *pacificus*. FISHER, 1911 a p. 30, also was of opinion that »*vicinus* is insecurely separated from *pacificus*». H. L. CLARK, 1920 p. 77, on the other hand maintained *vicinus* as a separate species, stating as differences from *pacificus* »the adambulacral spines, which are very small (short and slender) and are placed close together at the adoral end of the plate», and »the spinulation of the oral plates, which have only one, or sometimes two minute conical spines near the center of

the margin, instead of 2—5 large, flat spines occupying practically the entire margin». In the present specimens the adambulacral spines are like those described for *pacificus*, whereas the jaws have only two small spines at the outer end of the margin of each mouthplate and are like those described for the specimens referred to as *vicinus*.

The differences between the present specimens and the descriptions given of *vicinus* by LUDWIG and CLARK are so insignificant that the specimens must belong to the same form. The differences between *vicinus* and *pacificus* moreover can only be regarded as insufficient for maintaining *vicinus* as a separate species, the more so as the present specimens agree with *pacificus* in that character by which they differ slightly from the specimens described as *vicinus;* viz. the adambulacral spines. The specimens collected in the Atlantic, therefore, are ranged here under the name of *E. pacificus*.

Besides its previously known wide north-south distribution in the eastern Pacific, *E. pacificus* occurs in the Atlantic, and consequently should be considered a cosmopolitan deep-sea species. Its bathymetrical range is 1,550 to 5,780 m.

Styracaster horridus Sladen 1883

Fig. 2.

SLADEN 1883 pp. 229—232; 1889 pp. 150—152, pls. 23 5—7, 27 17—20.

KOEHLER 1909 b pp. 38—39; 1921 p. 2.

Non. *St. horridus* WOOD-MASON & ALCOCK 1891 p. 434, ALCOCK 1893 p. 86, = *St. caroli* LUDWIG.

Material: St. 329 (Haul No. 3), N 09° 38′ W 26° 20′ — N 09° 50′ W 26° 30′, July 3rd 1948; depth 5,610—5,600 m. 3 specimens.

The type-specimen of this species was collected by the »Challenger» in the eastern Atlantic, 2° 42′ S, 14° 41′ W, 4,300 m, and some other specimens have been recorded by KOEHLER, op. cit., from a few more nor localities, off the Bay of Biscay and e the Azores, 4,870 to 5,413 m.

The type-specimen had R. 75 mm, r. 1 7—9 cribriform organs, and 23 supero nals. The smaller one of the two spec described by KOEHLER, 1909 b, had R. 3 r. 9 mm, and 5 cribriform organs, the one had r. no less than 22 mm, but unfo tely had lost its arms; it appears to have cribriform organs. The specimens record KOEHLER in 1921 have not been des The present specimens have the fol measurements:

R.	r.	Number of cribriform organs	Number of supero-marginals.	Num arm
30—32 mm	8—9 mm	7—9	15—17	8
23—24 mm	7.5 mm	7	13—15	2 3
13 mm	4—5 mm	7	11	3

In the smallest specimen the dorsal ar has the appearance of a covering wit blunt spines, which should be interpre the shafts of the later paxillae, and in t largest specimens these shafts may bea one to three granuliform spinelets. The marginals of the fifth pair usually meet mid-radial line, but those of the sixth the first to join in their whole lengt terminal plates bear three spines, ve and slender in the smallest specimen, (worn down) and thicker in the largest sp The cribriform organs in the youngest s already number seven in each interbr the outer ones, however, are rudi In the two other specimens there ar distinct cribriform organs in each interb and in the largest one there may be tional rudimentary organ on either that the number of cribriform organs interbrachia of this specimen is incre nine. In the largest specimen there i the dorsal side of the arms, a row of 7— near the disk slightly exceeding the h

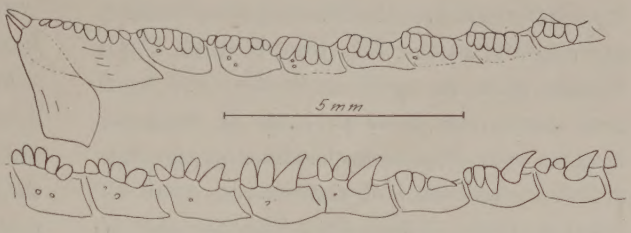

Fig. 2. *Styracaster horridus*. The adambulacral armature. Above of the medium-sized specimen, below of the adambulacralia nos. 3 to 10 in the largest specimen.

rm and thereupon fairly regularly
asing in length towards the tip
n. The first spine is found on
f the plates in the first pair of
omarginals of the arms, there
even be two large spines on this
and the other spines follow
one spine more or less regularly
ch pair of superomarginals. In
o smallest specimens, with only
r three arm spines, the first one
ways found at the arm base whereas
ext one may be on the successive plate
so on one of the more distal supero-
nals. In one of the smallest specimens
r two spinelets occur on the upper end
most distal pair of meeting superomar-
. The jaws bear a pair of strong conical
at their tip, and in the two largest
iens 9 blunt and flattened spines on
side, whereas in the small specimen
are, apparently, only 7—8 spines on the
of the jaws. On the ventral surface of
ws there may be a couple of granules.
dambulacral armature varies somewhat
hout the radius. The spines on the
ulacral plates of the disk are subequal,
same appearance as those of the jaws,
esent in a number of 3—4 in the smallest
en, 4—5 in the largest one, and 5—6 in
edium-sized specimen. In the arms,
in the most distal parts, there are
3—4 adambulacral spines, the aborally
spine generally larger than the others.
e smallest and largest specimens this
ly placed spine is spiniform, in the
dimsized specimen, however, blunt and
ed like the other adambulacral spines,
re fig. 2.

It is beyond doubt that the specimens here described belong to *Styracaster horridus*, the nominal species of *Styracaster*. The largest of the specimens, though it is much smaller than the type-specimen described by SLADEN, clearly shows this, and, on the other hand, proves the affinity of the smaller specimens with the type-specimen of *horridus* though they differ from it in a character, viz. the absence of dorsal paxillae, which is otherwise considered to distinguish the species specifically, in this case, however, because the paxillae are rudimentary. The smaller specimens further have a much smaller number of arm spines than the adult specimens.

Besides the genotype a number of other species of *Styracaster* have been described from the Atlantic as well as from the Indopacific Ocean.

The few species of *Porcellanasteridae* which, like *Porcellanaster cæruleus* and *Hyphalaster parfaiti*, are thoroughly known in a sufficient number of specimens show a wide range of variation. This variation is proved to be intraspecific, since it is found partly in specimens of the same lot, and since the outer limits of the variation are connected through transitional specimens. In view of the wide variation of these species it seems very doubtful whether all the species of *Styracaster* hitherto described can be maintained, the more so as a number of the species seem to be described on juvenile specimens only. The interrelationship and validity of the species are, however, difficult to ascertain. A much larger material of specimens than known at present is needed for a thorough revision of the genus and for showing which characters may be relied upon in the description of species.

From the Atlantic the following species of

Styracaster have been described besides *horridus*, viz. *edwardsi* Perrier 1894 from S. of the Cape Verdes, 3,655 m, *spinosus* Perrier 1894 from near the Azores, 2,995 to 4,360 m, *elongatus* Koehler 1907 from some localities in the Bay of Biscay and east of the Azores, 3,910 to 4,360 m, *chuni* Ludwig 1907 from the Bay of Guinea, 2,492 m, and *chuni* var. *groenlandica* Lieberkind from the Davis Strait, 3,229 m.

Of these species *edwardsi* and *spinosus* were described on juvenile specimens only. Perrier states as difference between them that the adambulacral spines are blunt in the former, but spiniform in the latter. This character, the only one in which the species do not agree, is of no distinguishing value, however, for which reason *spinosus* must be considered a synonym of *edwardsi*. All the specimens, which Perrier, 1894, and Koehler, 1909 b, have referred to these species, had three cribriform only.

Koehler, 1909 p. 38, discusses the possibility that his *St. elongatus*, might be the adult form of *edwardsi* or *spinosus*, but thinks it disproved by the absence of paxillae on the dorsal side of the latter species and by their somewhat different adambulacral armature. That the species have been described as being without paxillae may be due to the fact that these were rudimentary, and the character of the adambulacral armature, presumably, also can not be relied on. The possibility that *elongatus*, the larger specimens of which had 5—7 cribriform organs, may prove to be the adult form of *edwardsi* therefore cannot be entirely excluded.

St. elongatus otherwise seems to be very nearly related to *horridus*, only differing from this in having a more robust appearance, a somewhat different adambulacral armature and a smaller number of cribriform organs. It is not justifiable at present to unite *elongatus* with *horridus*, but it may be pointed out that the characters by which they differ are such as are usually very variable.

St. chuni is also very nearly relate *horridus*.

From the South Atlantic, 51° 09′ S, 9° 3 3,850 m, a species, *St. robustus* Koehler 19 described which is clearly distinguished the *horridus* group by its short arms with two spines in connection with a high nu of cribriform organs (11).

Five species have been described fro Indopacific: *St. armatus* Sladen 1883 fro Pacific, mid-ocean, 3,383 m, and by W Mason & Alcock 1891 further recorded the Bay of Bengal, 3,365 to 3,520 m, *cl* Wood-Mason & Alcock 1891 from the of Bengal, 3,197 m, *monacanthus* L 1907 from the eastern Mid-Pacific, 4,1 *paucispinus* Ludwig likewise from the e Mid-Pacific, 4,240 m, and *caroli* L 1907 from the Indian Ocean, off Africa, and the Bay of Bengal, 2,7 3,290 m.

The four first-mentioned species seem described on juvenile specimens only moreover the description of *clavipes* insufficient that it leaves the species more than a nomen nudum. The three species are all characterized by a lower n of superomarginals than present in spe of the *horridus* group of corresponding s

The last mentioned species, *St. caroli* ever, belong in the *horridus* grou specimens which are referred to this by Koehler, 1909 a, were in fact by Mason & Alcock, 1891 p. 434, design *horridus*. It may be impossible to m *caroli* as different from *horridus*.

St. horridus is, however, at present, with certainty only from the eastern A about 2° S—45° N, at 4,300 to 5,600 m

Chunaster scapanephorus Ludwig

Ludwig 1907 pp. 316—317, Lieberkin pp. 288—291, textfig. 11, pls. 1 7, 6 16—18, 7 4.

rial: St. 342 (Haul No. 4), N 01° 03′ 8° 40′ — N 00° 58′ W 18° 37′, July 16th ; depth 5,250—5,300 m. 6 specimens.

species — and genus — was hitherto only from the type-specimen from of Sumatra, 5,248 m. This was described DWIG in 1907 and in more detail by RKIND in 1935. It had R. 89 mm, r. , 30 superomarginals, and 11 cribriform . The present specimens are considesmaller, measuring:

	r.	Number of superomarginals.	Number of cribriform organs.
	11 mm	?	7
m	12 mm	19	8—9
m	14 mm	18—19	7—9
mm	16 mm	19	7—8
	16—17 mm	?	7—8
m	16—17 mm	18—?	7

The smaller number of cribriform organs comparison with the type is explained the younger age of the present specimens. also appears very distinctly that the cribriform organs here are in development. There one well developed cribriform organ at the adius and three similar ones on either e, he number of rows of spinelets in the gan varying from 10 in the most narrow dia ones to 18 in a specimen in which the ojoining cribriform organs nearly coalesce. sion these cribriform organs there may an additional one on one side or, in two of pecimens, on either side of the interam. These rudimentary cribriform orons consist of only a few rows of spinelets and en to not yet reach from the dorsal to the ntr side of the marginals.

Apart from the smaller number of cribriform organs the present specimens agree well th he type-description, for which reason a rmarks on the variation may suffice.

number of granules on the paxillae is erly four, but may amount to seven. Sometimes even the fifth pair of superomarginal plates meet dorsally, but usually they join from the sixth pair. The number of superomarginals is 18—19, but in the largest specimen it may have been somewhat more since the only arm preserved in this specimen has 18 superomarginals though the tip is regenerating. The 1—2 outermost and youngest superomarginals are separated by the terminal plate. There may be only two terminal spines or as many as four, in which case there is a row of two spines on the dorsal side of the terminal plate besides the pair at the end. On the preserved arms there may be from 10 to 14 dorsal spines and in addition a few nodules representing rudimentary arm spines. The arm spines are placed more or less regularly alternating on superomarginals of the left and the right side; but a successive number of spines may all belong to superomarginals of the same side of the arm. A slight irregularity in the superomarginal plates is found in one arm in which an additional plate is pushed in between two other plates without reaching the dorsal side of the arm. The inferomarginals correspond in number to the superomarginals with which they partly subalternate in the arms. The adambulacral armature — when preserved — is as described for the type-specimen. Superambulacral plates are not present.

LIEBERKIND, 1935 p. 290, says about the terminal plate that: »Sie ist mit ganz feinen Granula von gleicher Beschaffenheit wie die der Marginalplatten bekleidet». This might give the impression that these plates are covered with granuliform spinelets, which, however, is not the case; what LIEBERKIND calls »Granula» are only thorny microscopic protuberances.

Chunaster scapanephorus is thus now known to be distributed in the tropical Atlantic as well as in the tropical Indian Ocean. Both records are from depths of 5,250—5,300 m.

Hyphalaster parfaiti Perrier 1894

LIEBERKIND 1935 pp. 19—26, pls. 1 7—9, 3 1—11, 5 9, 11—14. (With list of literature).

Material: St. 342 (Haul No. 4), N 01° 03′ W 18° 40′—N 00° 58′ W 18° 37′, July 16th 1948; depth 5,250—5,300 m. 17 adult + 2 juvenile specimens.

St. 357 (Haul No. 6), N 02° 26′ W 39° 26′—N 02° 24′ W 39° 12′, July 26th—27th 1948; depth 4,474—4,430 m. 3 specimens.

This species has been dealt with at length by LIEBERKIND, op. cit., and a few remarks on the present specimens will therefore suffice. The three specimens from the St. 357 range from R/r = 24/11 mm to R/r = 32/14 mm and have 7—9 cribriform organs in each interbrachium. The adult specimens from the other locality range from R/r = 32/11 mm to R/r = 43/16 (—?/17) mm and have 9—11 cribriform organs. The measurements of the two juvenile specimens are:

R.	r.	Number of superomarginals.	Number of cribriform organs.
12 mm	6 mm	6—7	5
12.5 mm	6.5 mm	7—8	7

The paxillae are not yet fully developed on the dorsal side of these juvenile specimens, only some of the later paxillar shafts are provided with a few granules. As another perhaps specially juvenile character may be mentioned the presence of a few small plates in the angles between the first pair of joining superomarginals. Such additional plates are also found in some somewhat larger specimens from south of Greenland, but are not found in older ones.

LIBERKIND, op. cit., has shown that all the other species of *Hyphalaster* hitherto described from the Atlantic, viz. *antoni* Perrier 1894, *fortis* Koehler 1907 a, and *gracilis* Koehler 1907 a, are only synonyms of *parfaiti*. This species is thus known throughout the main part of the Atlantic, from the Davis southwards to about the Equator, at from 2,400 to 5,430 m. Attention may be called to *H. scotiae* Koehler 1907 b fr Antarctic, 71° 22′ S, 16° 34′ W, 2,510 m, species possibly also should be ranged the synonyms of *parfaiti*, being at an very nearly related to it.

. Since other species of the Atlantic lanasterids are known to occur also Indopacific it might be expected that other of the species of *Hyphalaster* de from the Indopacific should be identic *parfaiti*.

H. hyalinus Sladen 1883 from the Pacific, 5,020 m, the genotype of *Hyph* was, unfortunately, described on a j specimen, but differs clearly from a other Hyphalasters in which the supero nals meet dorsally by having the marginals of the disk furnished with a spine on the upper end.

H. diadematus Sladen 1883 from off 3,950 m, and *planus* Sladen 1883 fr Indian Ocean SW of Australia, 3,560 nearly related and differ from all other lasters in having the superomarginal separated throughout the arms.

H. tara Wood-Mason & Alcock 189 the Indian Ocean, the Bay of Beng east of Somaliland, 3,190 to 3,872 m, from the other Hyphalasters in the co tively few superomarginals and in only three cribriform organs. Judgin WOOD-MASON & ALCOCK's original des and figures it might be suspected th species in reality is an *Eremicaster*, however, can not be the case, since 1938, keeps it in *Hyphalaster*.

The three remaining species are all related to each other and to *parfaiti* are: *inermis* Sladen 1883 from Japan, 3 *moseri* Ludwig 1905 from the Mid 4,504 m, and *gigantea* Macan 1938 f Indian Ocean east of Somaliland, 3,840

s far as our present knowledge runs the nces stated between them and *parfaiti* ot convincing, so that one or other of may be identical with *parfaiti*. Further al is, however, necessary to decide this.

ioracaster cylindratus Sladen 1883

ylindratus LIBERKIND 1932, pp. 285—extfig. 10, pls. 2 1—2, 3 12—14, 4 1, . (With list of literature).
agnus LUDVIG 1907 pp. 313—314, H. L. 1920 pp. 78—79, FISHER 1928 p. 487.

erial: St. 357 (Haul No. 6), N 02° 26′ 9° 26′—N 02° 24′ W 39° 12′, July 26th—1 1948; depth 4,474—4,430 m. 2 specis.

surements of the specimens:

	r.	Number of supero-marginals.	Number of cribriform organs.
–5 mm	16 mm	19—20	12 (—13)
–6 mm	14 mm	18	12 (—14)

re are 12 distinct cribriform organs in nterbrachium, and in some interbrachia may be an additional faint rudiment of an organ on one or on both sides. The marginals correspond in the main to the marginals, though there may be some irregularity. In one arm, for example, f the usual inferomarginals are replaced very long one which then corresponds to uperomarginals. Or an inferomarginal may be very small, triangular, and replaced by the neighbouring infero-als which meet below it. The paxillae ear as many as 9 granuliform spinelets. erminal plate in the larger specimen is d and devoid of spines, in the smaller it a few nodules representing the worn bases of the terminal spines found in the le specimens, cf. the figure given of *Pseudaster cordifer* (the juvenile *T. cylindratus*) by PERRIER, 1894 pl. 16_3.

T. cylindratus is recorded from a number of localities in the eastern Atlantic between 0° and about 40° N, 4,275 to 4,990 m, and to this is now added the above locality from the western Atlantic.

From the eastern Pacific, between 0° and about 10° S, 3,170 to 4,335 m, another species, *T. magnus* Ludwig 1907, is described, which I do not hesitate to declare identical with the Atlantic *T. cylindratus;* and we thus have here another deep-sea species with a world-wide distribution.

A third species, *T. alberti* Koehler 1909, is described from the Arabian Sea, 2,750 m. It is clearly distinguished from *cylindratus* by having the marginal plates furnished with spines.

Only two of the genera of Porcellanasteridae have not hitherto been met with in the Atlantic, viz. *Sidonaster*, of which three nearly related species, *vaneyi* Koehler 1909, *batheri* Koehler 1909, and *psilonotus* Fisher 1913, have been described from the Indian Ocean and western tropical Pacific, about 1,200 to 2,500 m, and *Benthogenia cribellosa* Fisher 1911 from the Philippines, 925 m, which latter depth is the shallowest at which a Porcellanasterid has hitherto been collected.

Pteraster sp. ?

Material: St. 373 (Sledge-Trawl) N 28° 25′ W 61° 05′—N 28° 05′ W 60° 49′, Aug. 23th—24th 1948; depth 5,500—5,987 m. 1 specimen.

Unfortunately the single specimen present has been so damaged in the sledge-trawl that it cannot be identified. It is five-armed and has a diameter of about 25 mm. It is a Pterasterid, probably a *Pteraster* sp., but even this cannot be said with certainty.

Freyella benthophila Sladen 1889

Sladen 1889 pp. 641—643, pl. 111 5—8; Wood-Mason & Alcock 1891 p. 440; Alcock 1893 p. 121.

Material: St. 401 (Haul No. 14), N 43° 40′ W 18° 45′—N 43° 24′ W 18° 59′, Sept. 15th 1948; depth 5,000—5,025 m. 1 specimen.

The present specimen agrees perfectly with Sladen's description and figures of the type-specimen, which was collected by the »Challenger» in the South Pacific, 39° 41′ S, 131° 23′ W, 4,660 m. Only four of the original six arms are preserved and they are all somewhat damaged. R. can be estimated, however, to have been about 100 mm, r. is about 4.5 mm, the breadth of arm at base 3 mm and at greatest ovarial enlargement 5 mm. The ovarial region extends about 12 mm from the disk. The specimen is thus somewhat larger than the type, which had R. 88 mm and r. 3 mm.

It may be noted that there is only one pair of gonads in each arm so that the species belongs to *Freyella* also in the restricted sense given the genus by Fisher.

Besides from the type-locality in the South Pacific, *F. benthophila* has been recorded from the Bay of Bengal, 2,780 and 2,910 m, by Wood-Mason & Alcock op. cit., to which comes the here recorded find in the Atlantic. The species has thus a cosmopolitan deep-sea distribution.

Freyella tuberculata Sladen 1889

Sladen 1889 pp. 638—640, pl. 117 1—3; Alcock 1893 p. 121, H. L. Clark 1920 p. 113. (*Freyellidea t.*).

Material: St. 329 (Haul No. 3), N 01° 03′ W 18° 40′—N 00° 58′ W 18° 37′, July 3rd 1948; depth 5,250—5,300 m. Fragments of arms.

From this locality there are some frag of five arms which have been at least long. The very characteristic hexagonal sk plates of the dorsal side of the arms ar absence of a small furrow spine leav doubt that they belong to Sladen's *F. culata*, which was also collected by the » enger» in about the same locality, 2° 14° 41′ W, 4,298 m, as also in a locali tween the Cape Verdes and the Canar 4,390 m. The species has further been re from the Bay of Bengal, 3,365 m, by Ar op. cit., and from the eastern Mid-I 0° 03′ 24′ N, 117° 15′ 48″ W, 4,243 r H. L. Clark, op. cit, and thus also b to the cosmopolitan deep-sea species.

Freyella sexradiata Perrier 188

Perrier 1885 p. 442; 1894 pp. 89—90, Koehler 1909 pp. 129—130, pl. 1921 p. 2; Grieg 1921 pp. 30—31 fig

Material: St. 387 (Haul No. 13), N W 35° 24′—N 40° 34′ W 35° 52′, Sep 1948; depth 4,540—4,600 m. 1 arm.

The single arm present agrees with Pe description of the arms of the type, characterized among other features small furrow spine at the aboral end adambulacral plates. Fisher, 1928 notes that the affinity of this species, of *benthophila*, with the genus *Freyell* restricted sense was not proved ur number of gonads in the arms was Grieg, 1921, however, stated that the two in each arm, which is confirmed study of the present arm, and so *F. se* is also correctly placed in *Freyella* restricted sense given it by Fisher.

The above locality lies inside the pr known area of distribution of the spe Atlantic between about 38° N and 4

ay of Biscay, near the Azores, and off
ca. The bathymetrical distribution is
m to 4,700 m.

General remarks

stars occur from the lowest to the grea-
epths of the ocean explored. About one
of the species described have been
ed from depths exceeding 1,000 m, and
10 % are recorded from depths of more
3,000 m. A list of these latter species is
at the end of this paper. It should be
te however, that the list is not revised, but
enumerates the 137 species of deep-sea
is left when the synonyms stated in the
ure have been considered. Records of
ntified species from the deep-sea are not
ed in the list. A few species have deli-
ly been omitted although recorded from
ts of more than 3,000 m since the identi-
n of the deep-sea specimens may reason-
e doubted. Though the list only comprises
s recorded from depths of more than
0 m it gives a reasonable picture of our
t knowledge of the deep-sea fauna of
ars. Most conspicuous is the great
er of species known from a single or a
ocalities only, thus slightly more than
the number of the species listed are
n only from a single locality, very clearly
ating how deficient our present know-
is. It is also obvious that a special fauna
-stars actually exists in the deep-sea.
hymetrical distribution comprising also
s of less than 1,000 m is recorded for
11 of the species listed. Eight of these
s have been found also at depths of less
500 m, three of the species at depths of
an 200 m, and a single one at a depth of
an 100 m (viz. 80 m). The last-mentioned
s, however, has an antarctic distribution,
ne of the species from depths of less than
is arctic, and in both the Arctic and the Antarctic the temperature conditions favour a bathymetrical distribution extending from the deep-sea up into fairly shallow water.

The deep-sea asterids belong to 12 different families of which the following four, the Porcellanasteridae, Astropectinidae, Pterasteridae, and Brisingidae, comprise more than 2/3 of the species listed (viz. 103 species). The first of these families, the Porcellanasteridae, is the only one which has an exclusively deep-sea distribution, the shallowest depth at which a member of this family has ever been found being 925 m. But the Pterasteridae and the Brisingidae are also typical deep-sea families although they have a few representatives also in fairly shallow water (at depths of less than 100 m).

The greatest depth at which a sea-star has hitherto been collected is, as said above, 6,035 m (*Porcellanaster cæruleus*), and this is the only record of a sea-star from depths of more than 6,000 m; in addition, 14 species have been found at depths of more than 5,000 m, and 37 species are further recorded from depths of more than 4,000 m.

Any comparison of the sea-star fauna of the different areas of the deep-sea is rather futile at present, owing to our very heterogeneous knowledge. Best investigated is the eastern part of the Atlantic, between the Azores and Europe and northern West-Africa. A fourth of the species listed are known from this area, many of them from a number of localities.

The first part of this paper mentions four sea-stars with a cosmopolitan deep-sea distribution: the Porcellanasterids: *Eremicaster pacificus* and *Thoracaster cylindratus*, and the Brisingids: *Freyella benthophila* and *F. tuberculata*, and, as indicated, some others of the Porcellanasterids may also be suspected to be cosmopolitan; but no other deep-sea sea-stars have hitherto been recorded from similar widely distributed localities.

Two species, *Psilaster charcoti* and *Pergamaster incertus*, are circum-antarctic, and pro-

bably such a distribution will prove to be the usual one for the antarctic deep-sea species.

The deep-sea fauna of the Atlantic and the Indian Ocean may be expected to have many sea-stars in common; but only 5 of the species listed below are hitherto known to occur both in the Atlantic and in the Indian Ocean. A few of the species known from the Indian Ocean are recorded also from the deep w between the East-Indian islands; but, from the cosmopolitan species mentioned a only one species, *Marsipaster hirsutu* recorded both from the Indian Ocean and the eastern Pacific. It might be jus therefore to suggest that this species is cosmopolitan.

LIST OF THE SPECIES OF SEA-STARS RECORDED FROM DEPTHS OF MORE THAN 3000 M, WITH INFORMATION OF DISTRIBUTION. (Synonyms in brackets).

	The Atlantic Ocean	The Indian Ocean	The Pacific Ocean	Dep in
Porcellanasteridae				
Porcellanaster				
caeruleus W.-Th. [eremicus Sl., inermis Perr., pedunculatus (Perr.), sladeni (Perr.), richardi (Perr.)]	Many localities, ca 65°N to 40° S	?		1,435–
tuberosus Sladen			34°5 N, 140°5 E	3,4
granulosus Perrier	The Cape Verdes			2,320–
caulifer Sladen		Arabian Sea; Bay of Bengal	6° S, 134° W	1,460–
dubius (Koehler)		Bay of Bengal		3,2
nudus (Ludwig)			4°5 S, 87°5 W	3,6
Eremicaster				
tenebrarius (Fisher) [waltharii Ludwig]		Arabian Sea	Eastern Pacific from Alaska to Peru	2,420–
crassus (Sladen) [gracilis (Sladen)]			33° S, 133° W; Off Chili	4,070–
pacificus (Ludwig) [vicinus (Ludwig)]	10° N, 26°5 W		Eastern Pacific from Bering Sea to Peru	1,550–
Styracaster				
horridus Sladen	Eastern Atlantic, ca 45° N to 2° S	?		4,300–
caroli Ludwig		Bay of Bengal; Zanzibar		2,780–
elongatus Koehler	Bay of Biscay; E. of the Azores			3,910–
chuni Ludwig	Bay of Guinea; Davis Strait			2,490–
edwardsi Perrier [spinosus Perrier]	The Azores; the Cape Verdes			2,995–
armatus Sladen		Bay of Bengal	8° N, 144°E	3,360–
clavipes Wood-Mason & Alcock		Bay of Bengal		3,1
robustus Koehler	51° S, 9°5 W			3,8
monacanthus Ludwig			19° S, 102° W	4,[illegible]
paucispinus Ludwig			8°5 S, 85°5 W	4,[illegible]
Chunaster				
scapanephorus Ludwig	1° N, 18°5 W	S. of Sumatra		5,200–

	The Atlantic Ocean	The Indian Ocean	The Pacific Ocean	Depths in m
phalaster				
us Sladen			7°5 S, 152° W	5,020
ti Perrier	Many localities, especially in the eastern Atlantic, 60° N to 0°			2,400—5,430
ii Perr., fortis Koehl., gracilis hl.]				
eus Macan		Off Somaliland		3,480—3,870
is Sladen			34°5 N, 140°5 W	3,430
i Ludwig			1° N, 138° W	4,505
natus Sladen			33°5 S, 74°5 W	3,950
s Sladen		54° S, 108°5 E		3,560
Wood-Mason & Alcock		Bay of Bengal; off Somaliland		3,195—3,870
oracaster				
ratus Sladen	Eastern Atlantic ca 40° N to 0°		Eastern Pacific ca 0° to 10° S	3,170—4,990
fer Perr., valdiviae Ludw., magnus dw.]				
Benthopectinidae				
nthopecten				
us Verrill	Many localities ca 60° N to 20° N			1,060—3,700
-quamatus var. occidentalis (Sl.), iatus (Sl.)]				
ticus (Sladen)		66° S, 80° E		3,065
fer (Sladen)	Cape of Good Hope	46°S, 48°5 E		2,595—3,475
quamatus (Sladen)		Bay of Bengal	Japan; East Indies	925—3,430
tus (Ludwig)			Bay of Panama.	3,060
ctinaster				
nus (Sladen)	37° S, 46° W			4,845
Perrier	Many localities, ca 45° N to 37° S	47° S, 45°5 E		1,165—3,705
stus (Sl.), forcipatus (Sl.)]				
idiaster				
ticus (Koehler)	62° S, 41°5 W			3,230
Astropectinidæ				
rsephonaster				
is (Sladen)		Bay of Bengal; Arabian Sea; Zanzibar	Japan	2,925—3,870
anthus W.-M. & Alck.]				
is (Koehler)	48° S, 10° W			3,115
tis H. L. Clark	West Indies			2,925—3,290
utonaster				
izii (Verrill)	Many localities from 45° N to 23° N; Cape of Good Hope			335—3,110
us Sl., granulosus Perr., intermedius rr.)]				
thybiaster				
fer Wyville-Th.	Many localities in the Norwegian Sea (to 80° N); off the British Isles; Davis Strait; off U. S. A.; Cape of Good Hope			225—3,110
bilis (Dan. & Kor.), robustus (Verr.)				
nilus (Sl.), pallidus Ludwig].				

	The Atlantic Ocean	The Indian Ocean	The Pacific Ocean	Dept... in
Psilaster				
pectinatus (Fisher) [abyssicola (Ludwig)]	.....	.....	Bering Sea; California; Bay of Panama	1,865–
charcoti (Koehler) [longispinus (Koehl.)]	ca 55° S to 62° S and 5° E to 55° W	ca 65° S to 67° S and 92° E to 145° E	ca 62° S to 63° S and 65° W to 95° W	80–
Lonchotaster				
tartareus Sladen	22°5 N, 22° W	.....	.....	4,3
forcipifer Sladen	.....	62°5 S, 96° E; 54° S, 108°5 E	.....	3,570–
Dytaster				
agassizii Perrier	Bay of Biscay; between the Azores and Europe	.....	.....	3,120–
biserialis Sladen	Between the Azores and Europe	.....	.....	3,705–
exilis Sladen	Off the northern U. S. A.; 36° S, 21° W	Bay of Bengal	.....	2,515–
gilberti Fisher [demonstrans Ludwig]	.....	.....	Eastern Pacific, California to Peru	3,170–
grandis (Verrill) [madreporifer Sl.]	Off the northern U. S. A.	.....	.....	2,020–
inermis Sladen	.....	3° N, 125° E	.....	3,9
nobilis Sladen	37° S, 46° W	.....	.....	4,8
parvulus Koehler	37° N, 20° W	.....	.....	4,2
rigidus (Perrier)	Bay of Biscay; between the Azores and Europe	.....	.....	4,445
semispinosus (Perrier)	44°5 N, 16° W	.....	.....	4,975–
spinosus Sladen	.....	.....	36° N, 178° E	3,7
spinulosus (Perrier)	44°5 N, 19°5 W	.....	.....	4,2
Goniasteridae				
Chitonaster				
cataphractus Sladen	.....	62°5 S, 96° E	.....	3,(
johannae Koehler	62° S, 41° W	.....	.....	3,2
Mediaster (?)				
elegans Ludwig	.....	.....	Bay of Panama	1,790
Nymphaster				
arenatus (Perrier) [protenteus Sl., jacqueti (Perr.), prehensilis (Perr.), ? subspinosus (Perr.)]	Many localities between Ireland and the Canaries; a number of localities in the W. Indies.	.....	.....	275—(
Litonaster				
intermedius (Perrier)	The W. Indies	The Laccadive Sea	.....	1,955
tumidus H. L. Clark	.....	.....	Off Peru	4,064
Pergamaster				
incertus Bell [tessellatus Koehler]	63°5 S, 54° W	97°—127° E, 64°5 S	Ross Sea, 77° S	175

	The Atlantic Ocean	The Indian Ocean	The Pacific Ocean	Depths in m
s a s t e r				
dri (Perrier)	Bay of Mexico			150—3,530
e u d a r c h a s t e r				
nus Verrill	Off U. S. A., 41°—41°5 N			225—3,275
r a g o n a s t e r				
s (Perrier)	Many localities 45° N to 0°			2,550—4,700
lratus Sl., elongatus Perr., strictus ., formosus (Verr.)]				
adiis Alcock		Bay of Bengal		3,200
p l a s t e r				
us Perrier	50° N, 15° W.; 38°5 N, 27°5 W			2,995—3,305
Odontasteridae				
o n t a s t e r				
is Koehler	48° S, 10° W			3,185
Ganeriidae				
n e r i a				
ata Koehler	62° S, 41° W			3,245
o t i a s t e r				
tus Koehler	51° S, 9° 5 W			3,845
Solasteridae				
l a s t e r				
cola Verrill	Off U. S. A., 36°—39° N; 45° N, 26° W			1,540—3,120
L p h a s t e r				
viatus Koehler	62° S, 41° W			3,245
P r a l o p h a s t e r				
Koehler	67°5 S, 36°5 W			4,570
Pterasteridae				
P e r a s t e r				
atus Perrier	42°5 N, 23°5 W			4,060
Koehler		64°5 S, 127° E		3,110
bilis (Perrier)	Bay of Mexico			3,515
M r s i p a s t e r				
issimus Sladen			33°5 S, 133°5 W	4,270
is Sladen		Bay of Bengal	33°5 S, 75° W	3,650—3,950
B n t h a s t e r				
e-thomsoni Sladen			35°5 N, 170° E	5,305
H m e n a s t e r				
s Sladen		50° S, 123° E		3,290
us Koehler		36° S, 136° E		3,290
odes H. L. Clark			8°5 S, 85°5 W	4,335
r Sladen		50° S, 123° E		3,290
Koehler	69°5 S, 15°5 W			4,790

	The Atlantic Ocean	The Indian Ocean	The Pacific Ocean	Dept in
echinulatus Sladen			23°5 S, 133°5 W	4,27
edax Koehler		62° S, 41° W		3,23
formosus Sladen		50° S, 123° E		3,29
geometricus Sladen			33°5 S, 133°5 W	4,27
giboryi Perrier	Some localities E. of the Azores			4,020—
gracilis Ludwig			Bay of Panama; off Ecuador	2,420—
infernalis Sladen			35° N, 169° W	5,3(
koehleri Fisher			Bering Sea	3,2
latebrosus Sladen	Off Cape of Good Hope	54° S, 108°5 E		1,460—
nobilis Wyville-Thomson		50° S, 123° E; Bay of Bengal		3,195—
pergamentaceus Sladen	37° S, 46° W			4,8
perissonotus Fisher			The eastern Pacific from the Bering Sea to California	410—
pudicus Koehler		36° S, 136° E		3,2
quadrispinosus Fisher			The eastern Pacific from the Bering Sea to California	1,935—
sacculatus Sladen		50° S, 123° E		3,2
trias H. L. Clark			Off Peru	5,2
violaceus Ludwig			15° N, 99° W	3,4
Myxasteridae				
Pythonaster				
murrayi Sladen	35°5 S, 51° W			3,4
atlantidis A. H. Clark	35°5 N, 31° W			3,9
Brisingidae				
Brisingella				
armillata (Sladen)			34°5 N, 140°5 W	3,
distincta (Sladen)		43° S, 134° E		4,
monacantha H. L. Clark			Off Peru	4,
submembranacea (Döderl.)		65° S, 80°—85° E		2,450- ,4
Craterobrisinga				
multicostata (Verrill)	Off U. S. A., ca 40° N			2,080- ,1
Freyella				
aspera Verrill	Off Chesapeake Bay			3,
attenuata Sladen			15° N, 142° E	4,
benthophila Sladen	43°5 N, 19° W	Bay of Bengal	39°5 S, 131°5 W	2,780 ,0
brevispina (H. L. Clark)			9° S, 123° W	4
drygalski (Döderl.)		65° S, 80° E		3
echinata Sladen			East Indies	1,920 ,9
elegans (Verrill)	Off U. S. A., Nova Scotia to the W. Indies			1,660 ,2
fragilissima Sladen		47° S, 46° E, 62° S, 96° E		2,515 ,6
giardi Koehler	68° S, 37° W; 70° S, 15° W			4,570 ,7
heroina Sladen			35° N, 170° E	5

	The Atlantic Ocean	The Indian Ocean	The Pacific Ocean	Depths in m
is Ludwig			Eastern Pacific from California to Ecuador	3,180—4,075
diata (H. L. Clark)			0°—9° S and 85° W—117° W	4,085—4,430
rachia (H. L. Clark)			7° S, 83°5 W; 0°, 117° W	4,065—4,245
ta Sladen			Japan	3,430
Koehler	32° N, 43° W			3,465
Sladen			14° S, 152° W	4,460
liata Perrier	Some localities ca 38° N to ca 45° N			1,460—4,700
a Perrier	The Cape Verdes; the Azores			2,320—4,060
ulata Sladen	Eastern Atlantic ca 3° S to ca 22° N	Bay of Bengal	0°, 117° W	3,365—4,390
Zoroasteridae				
roaster				
Sladen	(48° S, 0°)		2°5 S, 144° E	1,955—3,185
i Alcock		Bay of Bengal; Sea of Arabia		2,375—3,350
ficus Ludwig			Bay of Panama; Galapagos Isl.	3,060—3,665
us Ludwig			15° N, 99° W	3,435
auda Perrier	Eastern Atlantic, ca 16° N to ca 44° N			2,995—4,255
Asteridae				
drasterias				
ion (Sladen)	42° N, 63°5 W; 40° 5 N, 66° W			2,285—3,160
liata (Perrier)	Many localities between Europe and the Azores			600—4,255
omorphaster				
ani (Perrier)	Many localities in the eastern Atlantic from Ireland to the Azores and the Canaries			945—5,415

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